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GEH-01-064

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: John Belcea

Art Unit: 2123

Serial No.: 09/752,276

Examiner: Sharon, Ayal I.

Filed: December 29, 2000

For: ADAPTIVE TRAIN MODEL

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William Zychlewicz, Reg. No. 51,366
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, MO 63102-2740
(314) 621-5070

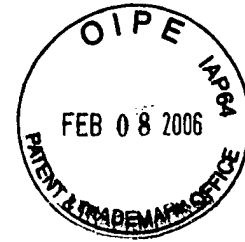## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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TRANSMITTAL LETTER ACCOMPANYING APPEAL BRIEF

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Alexandria, VA 22313

Transmitted herewith is the Appeal Brief in this application. The filing fee of $500.00 was submitted with the Notice of Appeal, filed September 8, 2005. As indicated in the enclosed Certificate of Mailing by Express Mail, the Appeal Brief is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service, on February 8, 2005.

In addition, and in accordance with 37 C.F.R. 1.136(a), a three month extension of time is submitted herewith to extend the filing of the Appeal Brief from November 8, 2005, through and including February 8, 2006. In accordance with 37 C.F.R. 1.17(a)(3), authorization to charge a deposit account in the amount of $1,020.00 to cover this extension of time request also is submitted herewith.

Respectfully submitted,

William Zychlewicz, Reg. No. 51,366
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740
(314) 621-5070

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: John Belcea

Serial No.: 09/752,276   Art Unit: 2123

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For: ADAPTIVE TRAIN MODEL

APPELLANT'S BRIEF

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313

The Notice of Appeal in this Application was filed on September 8, 2005.

TABLE OF CONTENTS

This brief contains the following sections under the headings and in the order set forth below.

I.   REAL PARTY IN INTEREST

The real party in interest in this appeal is GE Harris Railway Electronics, L.L.C., which has now changed its name to GE Transportation Systems Global Signaling LLC, a Delaware Limited Liability Company, and is a wholly owned subsidiary of the General Electric Company, a New York corporation.

II.   RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences which will directly affect, or be directly affected by, or have a bearing on, the decision in this pending appeal.

III.   STATUS OF CLAIMS

Forty-five (45) claims, in total, are in this application. Claims 1-45 are pending. Claims 1-45 stand rejected. Claims 6-13, 19-22, 28-35 and 41-44 are objected to. Claims 1-45 are on appeal.

IV.   STATUS OF AMENDMENTS

A Final Office Action was issued March 9, 2005 by the Examiner in response to Applicant's Amendment filed November 16, 2004. An amendment was filed on May 9, 2005. That amendment was not entered.

V.   SUMMARY OF CLAIMED SUBJECT MATTER

The following summary correlates claim elements to specific embodiments described in the application specification. The following summary is not intended to limit in any manner whatsoever the scope of the claims, nor provide an interpretation of the claims. Rather, the following summary is provided only to facilitate the Board's understanding of the subject matter of this appeal.

The present invention relates to an adaptive train model (ATM) that includes a semi-empirical mathematical model of a moving train consist used for simulating and predicting train reaction to external stimuli. The consist includes at least one locomotive and at least one railcar. The ATM utilizes a system including at least one sensor located on the train consist, a database, and a computer. More particularly, the ATM is used for predicting such things as, train acceleration, train speed after one minute, and a shortest braking distance of the train consist. The model is adaptive because it is built and updated while the train is moving. The model has a set of unknown parameters that are updated as the train consist is moving and new data are collected. Then, based on the most recently measured data, those parameters are used for predicting movement characteristics of the train consist.

An embodiment of a method of the inventions of this application for predicting train consist reactions to specific stimuli using a system including at least one measurement sensor located on a train consist, a data base, and a computer, wherein the train consist includes at least one locomotive and at least one railcar, includes the steps of collecting sensor data as the consist is moving, determining a consist force balance utilizing the sensor data and the computer, and determining a set of consist coefficients using the computer. The method also includes the step

of predicting train consist kinetic characteristic values using the consist force balance and the set of consist coefficients.

In another embodiment, a system of the inventions of this application for predicting reactions of a train consist to specific stimuli includes at least one measurement sensor located on the train consist, a data base, and a computer, wherein the train consist includes at least one locomotive and at least one railcar. The system is configured to collect sensor data as the consist is moving, determine a consist force balance utilizing the sensor data and said computer, and determine a set of consist coefficients using said computer. The system is also configured to predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients.

In a further embodiment, a method of the inventions of this application for determining a force balance for a train consist using a system including at least one measurement sensor located on the train consist, a data base, and a computer, wherein the train consist includes at least one locomotive and at least one railcar, and wherein the railcar includes at least on brake shoe, includes the steps of monitoring a force applied to the consist utilizing the at least one measurement sensor, generating force data with respect to the force applied, and communicating the force data to the computer.

The method also includes determining rolling forces according to the equation $F(rf) = M (Kr + Krv \, v(t))$; determining aerodynamic forces according to the equation $F(af) = Ka \, v(t)2$; determining elevation caused forces according to the equation $F(ef) = M (Ke1 \, E1(t) + Ke2 \, E2(t) + Ke3 \, E3(t) + Ke4 \, E4(t))$; determining braking forces caused by direction changes according to the equation $F(dbf) = M (Kp \, Cp(t) + Kl \, Cl(t))$; determining consist brake forces caused by application of the at least one brake shoe according to the equation $F(baf) = Kb1 \, B1(t) + Kb2$

B2(t)+ Kb3 B3(t)+ Kb4 B4(t); determining brake application dragging force using a fast building pressure model according to the equation Bff = min(0, max(1, (T + 3.86950758 * T2 + 0.23164628 * T3) / (16367.9101 + 111.652789 * T + 27.6134504 8 * T2 - 0.0026229 * T3))) Bcf; determining brake application dragging force using a slow building pressure model according to the equation Bfs = min(0, max(1, (Ts + 2.00986206 * Ts2 + 0.81412194 * Ts3) / (0.00067603+ 169.361303* Ts + 8.95254599* Ts2 + 0.58477705* Ts3); determining brake release using a fast release model according to the equation Rff = min(0, max(1, (t + 3.86950758 * t2 + 0.23164628 * t3) / (16367.9101 + 111.652789 * t + 27.6134504 8 * t2 - 0.0026229 * t3))) Bcf; determining brake release using a slow release model according to the equation Rfs = min(0, max(1, (t + 2.00986206 * t2 + 0.81412194 * t3) / (0.00067603+ 169.361303* t + 8.95254599* t2 + 0.58477705 * t3))) Bcs; determining dynamic brake force according to the equation F(dbf) = Kd D(t); and determining traction force.

The method also includes the steps of determining a final solution according to the equation F(t) = M (Kr + Krv v(t))+ Ka v(t)2 + M Ke1 E1(t) + M Ke2 E2(t) + M Ke3 E3(t) + M Ke4 E4(t) + M Kp Cp(t) + M Kl Cl(t) + Kb1 B1(t) + Kb2 B2(t) + Kb3 B3(t) + Kb4 B4(t) + Kr1 R1(t) + Kr2 R2(t) + Kr3 R3(t) + Kr4 R4(t) + Kd D(t) + Kt T(t).

More specifically, the invention is defined claim-by-claim as set forth below.

Independent Claim 1 recites a method for predicting train consist reactions to specific stimuli using a system including at least one measurement sensor located on a train consist, a data base, and a computer, the train consist including at least one locomotive and at least one railcar, said method comprising the steps of: (*See* Specification at page 3, lines 7-19.)

collecting sensor data as the consist is moving; (*See* Specification at page 3, lines 20-24.)

determining a consist force balance utilizing the sensor data and the computer; (*See* Specification at page 3, line 25 - page 4, line 1.)

determining a set of consist coefficients using the computer; and (*See* Specification at page 3, line 25 - page 4, line 1.)

predicting train consist kinetic characteristic values using the consist force balance and the set of consist coefficients. (*See* Specification at page 3, line 25 - page 4, line 13.)

Claim 2 depends from Claim 1 and further recites that said step of collecting sensor data comprises the steps of:

monitoring a force applied to the consist utilizing the at least one measurement sensor;

generating force data with respect to the force applied; and

communicating the force data to the computer. (*See* Specification at page 3, lines 20-24.)

Claim 3 depends from Claim 1 and further recites that said step of determining a consist force balance comprises the step of determining a set of consist kinetic elements. (*See* Specification at page 6, lines 4-9.)

Claim 4 depends from Claim 3 and further recites that said step of determining a set of consist kinetic elements comprises the step of determining rolling forces according to the equation:

$F_{(rf)} = M (K_r + K_{rv} v(t))$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train; and

$v(t)$ is the speed of the train as a function of time. (*See* Specification at page 6, line 19 - page 7, line 6 and Table 1.)

Claim 5 depends from Claim 3 and further recites that said step of determining a set of consist kinetic elements further comprises the step of determining aerodynamic forces according to the equation:

$F_{(af)} = K_a \ v(t)^2$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction; and

$v(t)$ is the speed of the train as a function of time. (*See* Specification at page 7, lines 7-13 and Table 1.)

Claim 6 depends from Claim 3 and further recites that said step of determining a set of consist kinetic elements further comprises the step of determining elevation caused forces according to the equation:

$F_{(ef)} = M \ (K_{e1} \ E_1(t) + K_{e2} \ E_2(t) + K_{e3} \ E_3(t) + K_{e4} \ E_4(t))$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(ef)}$ relates to the elevation caused forces of the train;

M is the total train mass;

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K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is the elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train; and

$E_4(t)$ is the elevation function relating to the fourth segment. (*See* Specification at page 7, lines 14-22 and Table 1.)

Claim 7 depends from Claim 3 and further recites that said step of determining a set of consist kinetic elements further comprises the step of determining braking forces caused by direction changes according to the equation:

$$F_{(dbf)} = M (K_p C_p(t) + K_l C_l(t))$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(dbf)}$ relates to the dynamic braking force of the train;

M is the total train mass;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train; and

$C_l(t)$ is the braking effect caused by the lateral friction. (*See* Specification at page 9, lines 9-15 and Table 1.)

Claim 8 depends from Claim 3 and further recites that at least one railcar includes at least one brake shoe, said step of determining a set of consist kinetic elements further comprises the step of determining consist brake forces caused by application of the at least one brake shoe according to the equation:

$$F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train; and

$B_4(t)$ is the brake function relating to the fourth segment. (*See* Specification at page 12, lines 16-25 and Table 1.)

Claim 9 depends from Claim 8 and further recites that said step of determining consist brake forces caused by application of the at least one brake shoe further comprises the steps of:

determining friction coefficients of the at least one brake shoe; (*See* Specification at page 12, line 16 - page 13, line 10.)

determining total brake application forces; and (*See* Specification at page 16, lines 4-10.)

determining total brake release forces. (*See* Specification at page 16, lines 11-18.)

Claim 10 depends from Claim 9 and further recites that said step of determining total brake application forces comprises the step of determining a brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = \min(0, \max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f$$ (*See* Specification at page 15, lines 1-4.)

wherein

Bf_f is the braking force of the train for fast building pressure;

T is the traction force of the train; and

Bc_f is the brake cylinder force of the train. (*See* Specification at page 14, line 8 – page 15, line 4 and Table 1.)

Claim 11 depends from Claim 9 and further recites that said step of determining total brake application forces comprises the step of determining a brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = \min(0, \max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3))) Bc_s$$ (*See* Specification at page 15, line 26 – page 16, line 2.)

wherein

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure; and

Bc_s is the brake cylinder force of the train. (*See* Specification at page 15, line 5 – page 16, line 2 and Table 1.)

Claim 12 depends from Claim 9 and further recites that said step of determining total brake release forces comprises the step of determining brake release using a fast release model according to the equation:

$$Rf_f = min(0, max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3)\ )) Bc_f$$

wherein

Rf_f relates to the fast release force of the train;

t is the time; and

Bc_f is the brake cylinder force of the train. (*See* Specification at page 16, line 19 – page 17, line 8 and Table 1.)

Claim 13 depends from Claim 9 and further recites that said step of determining total brake release forces comprises the step of determining brake release using a slow release model according to the equation:

$$Rf_s = min(0, max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3)\ )) Bc_s \quad (See$$
Specification at page 17, lines 21-25.)

wherein

Rf_s relates to the slow release force of the train;

t is the time; and

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Bc_s is the brake cylinder force of the train. (*See* Specification at page 17, lines 5-25 and Table 1.)

Claim 14 depends from Claim 3 and further recites that said dynamic brake force according to the equation:

$F_{(dbf)} = K_d D(t)$ (*See* Specification at page 18, line 6.)

wherein

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application; and

$D(t)$ is the dynamic brake force of the train. (*See* Specification at page 18, lines 6-11.)

Claim 15 depends from Claim 3 and further recites that said step of determining a set of kinetic elements further comprises the step of determining traction force. (*See* Specification at page 18, lines 12-15.)

Claim 16 depends from Claim 3 and further recites that said step of determining a force balance further comprises the step of summing the set of consist kinetic elements. (*See* Specification at page 6, lines 10-16.)

Claim 17 depends from Claim 1 and further recites that said step of determining a set of consist coefficients comprises the step of using a least squares method to determine consist coefficients. (*See* Specification at page 19, lines 4-9.)

Claim 18 depends from Claim 17 and further recites that said step of using the least squares method comprises the steps of:

weighting data;

solving the system; and

determining a confidence measure. (*See* Specification at page 19, line 4 – page 27, line 7.)

Claim 19 depends from Claim 1 and further recites that said step of predicting consist characteristic values comprises the steps of:

determining an acceleration prediction;

determining a speed after one minute prediction using the acceleration prediction; and

determining a shortest braking distance prediction using the acceleration prediction. (*See* Specification at page 27, line 9 – page 29, line 24.)

Claim 20 depends from Claim 19 and further recites that said step of determining an acceleration prediction comprises the steps of:

determining initial values; and

storing the initial values in the database. (*See* Specification at page 35, lines 1-5.)

Claim 21 depends from Claim 20 and further recites that said step of determining an acceleration prediction further comprises the step of determining the acceleration prediction value using a Euler method and the determined initial values. (*See* Specification at page 28, lines 1-21.)

Claim 22 depends from Claim 20 and further recites that said step of determining an acceleration prediction further comprises the step of determining the acceleration prediction value using a Milne method and the determined initial values. (*See* Specification at page 28, line 23 – page 29, line 24.)

Independent Claim 23 recites a system for predicting reactions of a train consist to specific stimuli, said system comprising at least one measurement sensor located on the train

consist, a data base, and a computer, the train consist comprising at least one locomotive and at least one railcar, said system configured to: (*See* Specification at page 3, lines 7-19.)

collect sensor data as the consist is moving; (*See* Specification at page 3, lines 20-24.)

determine a consist force balance utilizing the sensor data and said computer; (*See* Specification at page 3, line 25 – page 4, line 1.)

determine a set of consist coefficients using said computer; and (*See* Specification at page 3, line 25 – page 4, line 1.)

predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients. (*See* Specification at page 3, line 25 – page 4, line 13.)

Claim 24 depends from Claim 23 and further recites that said system is configured to:

monitor a force applied to the consist utilizing said at least one measurement sensor;

generate force data with respect to the force applied; and

communicate the force data to said computer. (*See* Specification at page 3, lines 20-24.)

Claim 25 depends from Claim 23 and further recites that said system further configured to determine a set of consist kinetic elements. (*See* Specification at page 6, lines 4-9.)

Claim 26 depends from Claim 25 and further recites that said system further configured to determine rolling forces according to the equation:

$$F_{(rf)} = M (K_r + K_{rv} v(t))$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train; and

$v(t)$ is the speed of the train as a function of time. (*See* Specification at page 6, line 19 – page 7, line 6 and Table 1.)

Claim 27 depends from Claim 25 and further recites that said system further configured to determine aerodynamic forces according to the equation:

$F_{(af)} = K_a\, v(t)^2$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction; and

$v(t)$ is the speed of the train as a function of time. (*See* Specification at page 7, lines 7-13 and Table 1.)

Claim 28 depends from Claim 25 and further recites that said system further configured to determine elevation caused forces according to the equation:

$F_{(ef)} = M\, (K_{e1}\, E_1(t) + K_{e2}\, E_2(t) + K_{e3}\, E_3(t) + K_{e4}\, E_4(t))$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(ef)}$ relates to the elevation caused forces of the train;

M is the total train mass;

K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

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$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is the elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train; and

$E_4(t)$ is the elevation function relating to the fourth segment. (*See* Specification at page 7, lines 14-22 and Table 1.)

Claim 29 depends from Claim 23 and further recites that said system further configured to determine braking forces caused by direction changes according to the equation:

$$F_{(dbf)} = M (K_p C_p(t) + K_l C_l(t))$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(dbf)}$ relates to the dynamic braking force of the train;

M is the total train mass;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train; and

$C_l(t)$ is the braking effect caused by the lateral friction. (*See* Specification at page 9, lines 9-15 and Table 1.)

Claim 30 depends from Claim 25 and further recites that said at least one railcar comprises at least one brake shoe, and to determine a set of consist kinetic elements, said system further configured to determine consist brake forces caused by application of said at least one brake shoe according to the equation:

$$F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train; and

$B_4(t)$ is the brake function relating to the fourth segment. (*See* Specification at page 12, lines 16-25 and Table 1.)

Claim 31 depends from Claim 30 and further recites that said system further configured to:

determine friction coefficients of said at least on brake shoe; (*See* Specification at page 12, line 16 - page 13, line 10.)

determine total brake application forces; and *(See* Specification at page 16, lines 4-10.)

determine total brake release forces. *(See* Specification at page 16, lines 11-18.)

Claim 32 depends from Claim 31 and further recites that said system further configured to determine a brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = min(0, max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f.$$

(See Specification at page 15, lines 1-4.)

wherein

Bf_f is the braking force of the train for fast building pressure;

T is the traction force of the train; and

Bc_f is the brake cylinder force of the train. *(See* Specification at page 14, line 8 – page 15, line 4 and Table 1.)

Claim 33 depends from Claim 31 and further recites that said system further configured to determine a brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = min(0, max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3))) Bc_s$$ *(See* Specification at page 15, line 26 – page 16, line 2.)

wherein

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure; and

Bc_s is the brake cylinder force of the train. (*See* Specification at page 15, line 5 – page 16, line 2 and Table 1.)

Claim 34 depends from Claim 31 and further recites that said system further configured to determine brake release using a fast release model according to the equation:

$$Rf_f = min(0, max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3))) Bc_f$$

wherein

Rf_f relates to the fast release force of the train;

t is the time; and

Bc_f is the brake cylinder force of the train. (*See* Specification at page 16, line 19 – page 17, line 8 and Table 1.)

Claim 35 depends from Claim 31 and further recites that said system further configured to determine brake release using a slow release model according to the equation:

$$Rf_s = min(0, max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3))) Bc_s$$ (*See* Specification at page 17, lines 21-25.)

wherein

Rf_s relates to the slow release force of the train;

t is the time; and

Bc_s is the brake cylinder force of the train. (*See* Specification at page 17, lines 5-25 and Table 1.)

Claim 36 depends from Claim 25 and further recites that said system further configured to determine dynamic brake force according to the equation:

$F_{(dbf)} = K_d D(t)$ (*See* Specification at page 18, line 6.)

wherein

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application; and

D(t) is the dynamic brake force of the train. (*See* Specification at page 18, lines 6-11.)

Claim 37 depends from Claim 25 and further recites that said system further configured to determine traction force. (*See* Specification at page 18, lines 12-15.)

Claim 38 depends from Claim 25 and further recites that said system further configured to sum said set of consist kinetic elements. (*See* Specification at page 6, lines 10-16.)

Claim 39 depends from Claim 23 and further recites that said system further configured to use a least squares method to determine consist coefficients. (*See* Specification at page 19, lines 4-9.)

Claim 40 depends from Claim 39 and further recites that said system further configured to:

weight data;

solve the system; and

determine a confidence measure. (*See* Specification at page 19, line 4 – page 27, line 7.)

Claim 41 depends from Claim 23 and further recites that said system further configured to:

determine an acceleration prediction;

determine a speed after one minute prediction using said acceleration prediction; and

determine a shortest braking distance prediction using said acceleration prediction. (*See* Specification at page 27, line 9 – page 29, line 24.)

Claim 42 depends from Claim 41 and further recites that said system further configured to:

determine initial values; and

store the initial values in said database. (*See* Specification at page 35, lines 1-5.)

Claim 43 depends from Claim 42 and further recites that said system further configured to determine the acceleration prediction value using a Euler method and said determined initial values. (*See* Specification at page 28, lines 1-21.)

Claim 44 depends from Claim 20 and further recites that said system further configured to determine the acceleration prediction value using a Milne method and the determined initial values. (*See* Specification at page 28, line 23 – page 29, line 24.)

Independent Claim 45 recites a method for determining a force balance for a train consist using a system including at least one measurement sensor located on the train consist, a data base, and a computer, the train consist including at least one locomotive and at least one railcar, the railcar including at least one brake shoe, said method comprising the steps of: (*See* Specification at page 3, lines 7-19.)

monitoring a force applied to the consist utilizing the at least one measurement sensor; (*See* Specification at page 3, line20 – page 4, line 1.)

generating force data with respect to the force applied; (*See* Specification at page 3, lines 20-24.)

communicating the force data to the computer; (*See* Specification at page 3, lines 20-24.)

determining rolling forces according to the equation $F_{(rf)} = M (K_r + K_{rv} v(t))$,

determining aerodynamic forces according to the equation $F_{(af)} = K_a v(t)^2$,

determining elevation caused forces according to the equation $F_{(ef)} = M (K_{e1} E_1(t) + K_{e2} E_2(t) + K_{e3} E_3(t) + K_{e4} E_4(t))$,

determining braking forces caused by direction changes according to the equation $F_{(dbf)} = M (K_p C_p(t) + K_l C_l(t))$;

determining consist brake forces caused by application of the at least one brake shoe according to the equation $F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$;

determining brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = \min(0, \max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f ;$$

determining brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = \min(0, \max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3);$$

determining brake release using a fast release model according to the equation:

$$Rf_f = \min(0, \max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3))) Bc_f ,$$

determining brake release using a slow release model according to the equation:

$$Rf_s = \min(0, \max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3))) Bc_s$$

determining dynamic brake force according to the equation $F_{(dbf)} = K_d\ D(t)$,

determining traction force; and

determining a final solution according to the equation:

$$F(t) = M\ (K_r + K_{rv}\ v(t)) + K_a\ v(t)^2 +$$
$$M\ K_{e1}\ E_1(t) + M\ K_{e2}\ E_2(t) + M\ K_{e3}\ E_3(t) + M\ K_{e4}\ E_4(t) +$$
$$M\ K_p\ C_p(t) + M\ K_1\ C_1(t) +$$
$$K_{b1}\ B_1(t) + K_{b2}\ B_2(t) + K_{b3}\ B_3(t) + K_{b4}\ B_4(t) +$$

$$K_{r1}\ R_1(t) + K_{r2}\ R_2(t) + K_{r3}\ R_3(t) + K_{r4}\ R_4(t) + K_d\ D(t) + K_t\ T(t)$$ (*See* Specification at page 6, lines 10-16.)

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train;

v(t) is the speed of the train as a function of time;

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction;

$F_{(ef)}$ relates to the elevation caused forces of the train;

K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is an elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train;

$E_4(t)$ is an elevation function relating to the fourth segment;

$F_{(dbf)}$ relates to the dynamic braking force of the train;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train;

$C_l(t)$ is the braking effect caused by the lateral friction;

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train;

$B_4(t)$ is the brake function relating to the fourth segment;

Bf_f is the braking force of the train for fast building pressure;

T is the traction force of the train;

Bc_f is the brake cylinder force of the train;

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure;

Bc_s is the brake cylinder force of the train;

Rf_f relates to the fast release force of the train;

t is the time;

Rf_s relates to the slow release force of the train;

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application;

$D(t)$ is the dynamic brake force of the train;

$F(t)$ is the force balance of the train;

K_{r1} is the corrective factor for friction in the first segment of the train;

$R_1(t)$ is the release function of the first segment;

K_{r2} is the corrective factor for friction in the second segment of the train;

$R_2(t)$ is the release function of the second segment;

K_{r3} is the corrective factor for friction in the third segment of the train;

$R_3(t)$ is the release function of the third segment;

K_{r4} is the corrective factor for friction in the fourth segment of the train;

$R_4(t)$ is the release function of the fourth segment; and

K_d is the corrective factor for the effect of the dynamic brake application.

VI.   GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A.   Objections to the Specification under 35 U.S.C. § 132 as introducing new matter.

B.   Claims 4-5, 14, 26-27, 36, and 45 stand rejected under 35 U.S.C. § 101 as being inoperative and lacking utility.

C.   Claims 1-3, 15-16, 23-25 and 37-38 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Gruber, P. et al., "Suboptimal Control Strategies for Multilocomotive Powered Trains", IEEE Transactions on Automatic Control, June 1982, Volume 27, Issue 3, pages 536-546 ("Gruber").

D.   Claims 17-18 and 39-40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Gruber in view of Claerbout, "Confidence Intervals" and "Data Modeling by Least Squares", Fundamentals of Geophysical Processing (FGDP), ("Claerbout FGDP") and further in view of Claerbout, "Spectral Factorization", Earth Soundings Analysis: Processing versus Inversion (PVI) ("Claerbout PVI").

VII. ARGUMENT

Applicant respectfully submits that the specification, as originally filed, supports the claims, and that each pending claim in the present application is definite, contains subject matter which is described in the specification in such a way as to enable one skilled in the art to which it pertains to make and/or use the invention, and is patentable over the cited art. Accordingly, Applicant respectfully traverses the rejections of the pending claims, and requests that the final rejection be withdrawn and that the pending claims be allowed. In support of these requests, a discussion regarding the patentability of the claimed recitations is set forth below.

A.   The Amendment Filed November 16, 2004 Does Not Add New Matter.

By way of reference, Table 1, which was amended by an Amendment filed November 16, 2004, is included below. Specifically, Table 1 was amended to provide corrected units for the following constants: Cl(t), Cp(t), D(t), Ei(t), Ka, Kei, Kl, Kp, Kr, and Krv.

TABLE 1

Symbol	Meaning	Unit
a	Acceleration	$feet/s^2$
a(t)	Acceleration as a function of time	$feet/s^2$
$B_i(t)$	brake functions	$feet/s^2$
$C_l(t)$	Braking effect caused by lateral friction when train is in curve	feet
$C_p(t)$	Braking effect caused by weight increase when train is in curve	feet
D	distance	feet
D(t)	dynamic brake	pounds
D_C	degree of a curve (angle for 100 feet of track)[1]	degrees
$E_i(t)$	Elevation function	Feet
F	Force	pounds
g	Gravitational acceleration (9.82 m/s^2 = 32.218 feet/s^2)	$Feet/s^2$
K_a	Corrective factor for the effect of aerodynamic friction	lbs/feet
K_{bi}	brake function coefficients	no unit
K_d	Corrective factor for the effect of dynamic brake application	no unit

Symbol	Meaning	Unit
K_{ei}	Corrective factor for the effect of elevation change on segment i of the train	s^{-2}
K_l	Corrective factor for the effect of lateral friction when train is in curve	s^{-2}
K_p	Corrective factor for weight increase when train is in curve	s^{-2}
K_r	Corrective factor for friction of a train rolling on straight horizontal track	$feet/s^2$
K_{ri}	release function coefficient	no unit
K_{rv}	Dynamic corrective factor for friction of a train rolling on straight horizontal track	s^{-1}
K_t	Corrective factor for the effect of throttle application	no unit
L	total train length	feet
L_i	length of segment i	feet
l_{ij}	length of the segment i section j of the train	feet
M	total train mass	lbs
M_i	mass of segment i	
m_{ij}	mass of the segment i section j of the train	lbs
N_{ax}	Number of powered axles	
p(t)	Pressure in brake pipe measured at front locomotive	psi
P_{max}	Maximum pressure in brake pipe	psi
R	curve radius	feet
$R_i(t)$	release functions	$feet/s^2$
L	train length	feet
T(t)	traction force	pounds
v	speed	feet/s
v(t)	speed as function of time	feet/s
vd	speed recorded in database	feet/s
W	total train weight	lbs
w_{ij}	weight of the segment i section j of the train	lbs

The following discussion sets forth the objection to the specification and summarizes current and applicable law with respect to the amendment filed November 16, 2004.

1.   The Cited Rejection

In the Office Action dated March 09, 2005, and made final, the Amendment to Table 1, and more particularly, to the units listed for the constants Cl(t), Cp(t), D(t), Ei(t), Ka, Kei, Kl,

Kp, Kr, and Krv, were objected to under 35 U.S.C. § 132 as introducing new matter. The Office

Action asserts that the changes to the units are not supported elsewhere in the specification.

2.   Applicable Law With Respect To 35 U.S.C. § 132

35 U.S.C. § 132, in pertinent part provides:

> (a) Whenever, on examination, any claim for a patent is rejected, or any
> objection or requirement made, the Director shall notify the applicant
> thereof, stating the reasons for such rejection, or objection or requirement,
> together with such information and references as may be useful in judging
> of the propriety of continuing the prosecution of his application; and if
> after receiving such notice, the applicant persists in his claim for a patent,
> with or without amendment, the application shall be reexamined. No
> amendment shall introduce new matter into the disclosure of the invention.

As is well established, no amendment shall introduce new matter into the disclosure of the

invention. However, it is equally well established that amendments to the specification are

proper to correct an obvious error. For example, as indicated in M.P.E.P § 2163.07, an

amendment to correct an obvious error does not constitute new matter where one skilled in the

art would not only recognize the existence of error in the specification, but also the appropriate

correction. *In re Oda*, 443 F.2d 1200, 170 USPQ 268 (CCPA 1971).

3.   The Objection To The Specification Is Improper.

Applicant respectfully submits that the objection to the specification under 35 U.S.C.

§ 132 is not a proper objection because the amendment to the units listed for the constants Cl(t),

Cp(t), D(t), Ei(t), Ka, Kei, Kl, Kp, Kr, and Krv in Table 1 does not constitute new matter.

Rather, Applicant respectfully submits that Applicant was merely correcting an obvious error.

Applicant submits that Table 1, as submitted in the original disclosure, included

typographical errors for the units of the following symbols: $C_l(t)$, $C_p(t)$, $D(t)$, $E_i(t)$, K_a, K_{ei}, K_l,

K_p, K_r, and K_{rv}. Additionally, Applicant submits that the units recited in Table 1 are for

illustrative purposes only, and one skilled in the art would have realized that the units for each of the symbols $C_l(t)$, $C_p(t)$, $D(t)$, $E_i(t)$, K_a, K_{ei}, K_l, K_p, K_r, and K_{rv} were in obvious error. One skilled in the art would not only recognize the existence of errors in the units of the constants, but also the appropriate correction.

With respect to the assertion that the amendment filed November 16, 2004 introduces new matter, Applicant respectfully disagrees and submits that the application as filed, does in fact support the changes to Table 1. The Federal Circuit has opined in *Verve LLC v. Crane Cams, Inc.*, 65 USPQ 2d 1051, 1053-1054 (Fed. Cir. 2002), that "[p]atent documents are written for persons familiar with the relevant field; the patentee is not required to include in the specification information readily understood by practitioners, lest every patent be written as a comprehensive tutorial and treatise for the generalist, instead of a concise statement for persons in the field." Applicant respectfully submit that one of ordinary skill in the art would agree that the subject matter in the specification is described in such a manner as to reasonably convey that the Applicant had possession of the claimed invention, at the time the application was filed. Specifically, Applicant respectfully submits that one skilled in the art would know the correct units for each of the symbols by the formulas recited in the original disclosure. By way of example only, and as indicated in the Office Action dated March 09, 2005, Newton's Second Law is $F=ma$. As such, one skilled in the art would realize that the rolling forces term $M(K_r + K_{rv} v(t))$, at page 6, line 18 of the original disclosure, would require the coefficient K_r to have an acceleration type unit, such as, for example, $feet/s^2$; and K_{rv} to have a unit, such as, for example, s^{-1}. As such, Applicant respectfully submits that the equations, as set forth in the original disclosure, and as understood by one of ordinary skill in the art, support the proper units for each

of the symbols illustrated in Table 1, as amended. Accordingly, Applicant respectfully requests that the objection to the specification be withdrawn.

B.   Claims 4-5, 14, 26-27, 36, and 45 Are Operative, Have Utility, And Satisfy 35 U.S.C. § 101.

The following discussion sets forth the Section 101 rejections cited against the pending claims and summarizes current and applicable law with respect to utility. In addition, a discussion of the rejection with respect to each pending claim, in view of current and applicable law, is provided. A claim-by-claim analysis of the pending claims also is set forth.

1.   The Cited Rejections

In the Office Action dated March 09, 2005, and made final, Claims 4-5, 14, 26-27, 36, and 45 were rejected under 35 U.S.C. § 101 as being inoperative and therefore lacking utility.

2.   Applicable Law With Respect To Utility

Section 101, in pertinent part provides:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3.   The Section 101 Rejection Of The Present Claims Is Not A Proper Rejection

Applicant respectfully submits that the Section 101 rejection of Claims 4-5, 14, 26-27, 36, and 45 is not a proper rejection. Specifically, as indicated above in response to the objection to the specification, the formulas in each of Claims 4-5, 14, 26-27, 36 and 45 produce the correct resultant units. As such, Applicant traverses the assertion that "these equations would produce incorrect ("inoperative") results. More specifically, the specification has been amended to

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provide corrected units for the constants and coefficients. As such, the Claims, particularly the formulas contained within the Claims, produce the correct resultant units. Accordingly, Applicant respectfully requests that the 101 rejection be withdrawn.

C.   Claims 1-3, 15-16, 23-25 and 37-38 Are Patentable Over Gruber.

The following discussion sets forth the Section 102 rejections cited against the pending claims and summarizes current and applicable law with respect to patentability. In addition, a discussion of the rejection with respect to each pending claim, in view of current and applicable law, is provided. A claim-by-claim analysis of the pending claims also is set forth.

1.   The Cited Rejections

In the Office Action dated March 09, 2005, and made final, Claims 1-3, 15-16, 23-25 and 37-38 were rejected as being unpatentable under 35 U.S.C. § 102(b) over Gruber.

2.   Applicable Law With Respect To Patentability

Section 102, in pertinent part provides:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States

As explained by the Federal Circuit, to satisfy the requirements of Section 102(b), which is generally referred to as "anticipation", each and every element of the claimed invention must be disclosed in a single prior art reference or embodied in a single prior art device. *Verdegaal Brothers Inc. v. Union Oil Company of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987).

3.   The Section 102 Rejection Of Claims 1-3, 15-16, 23-25 and 37-38 Is Not A Proper

Rejection

Applicant respectfully submits that the Section 102(b) rejections of presently pending Claims 1-3, 15-16, 23-25 and 37-38 are not proper rejections. Specifically, Gruber does not describe each and every recitation in Claims 1-3, 15-16, 23-25 and 37-38. For these reasons, Applicant respectfully requests that the Section 102(b) rejections be withdrawn, and respectfully traverses the rejection of Claims 1-3, 15-16, 23-25 and 37-38 under U.S.C. § 102(b) as being anticipated by Gruber.

Gruber describes a controller for operating multi-locomotive powered trains using suboptimal control strategies for minimizing coupler forces between the railcars. The control strategies are derived from two different small scale train models. One train model represents a reduced order model of the long train, the other train model uses a short train configuration consisting of fewer cars than the long train. From the two train models, a control law is predicted for the long train. Additionally, since not all of the parameters are measurable, the train models use estimates to determine the control law. As such, the results of the small scale train models obtained are adapted to the large scale system to determine the operations of the long train.

Claim 1 recites a method for predicting train consist reactions to specific stimuli using a system including at least one measurement sensor located on a train consist, a data base, and a computer, the train consist including at least one locomotive and at least one railcar, wherein the method includes "collecting sensor data as the consist is moving...determining a consist force balance utilizing the sensor data and the computer...determining a set of consist coefficients using the computer...predicting train consist kinetic characteristic values using the consist force balance and the set of consist coefficients."

Gruber does not describe or suggest a method for predicting train consist reactions to specific stimuli as recited in Claim 1. More specifically, Gruber does not describe or suggest a method including collecting sensor data as the consist is moving, determining a consist force balance utilizing the sensor data, and predicting train consist kinetic characteristic values using the consist force balance and a set of consist coefficients. Rather, in contrast to the present invention, Gruber describes a controller for operating multi-locomotive powered trains using sub-optimal control strategies derived from two different small scale train models and adapted to determine the operations of the long train. Notably, Gruber does not describe collecting sensor data and determining a train force balance using sensor data. As such, Gruber does not describe predicting train consist kinetic characteristic values using the consist force balance.

Moreover, Applicant respectfully traverses the suggestion in the Office Action at page 5, paragraph 12, that Gruber describes collecting sensor data. Specifically, the Office Action suggests that the "exchange of information along the train…" describes collecting sensor data. Applicant respectfully disagrees. Additionally, the Office Action suggests at page 13, paragraph 32 the "it is inherent that a control system collects sensor data, otherwise the control system cannot perform its intended function of controlling." Applicant traverses this suggestion. In fact, Applicant submits that Gruber does not describe or suggest collecting sensor data. Rather, Gruber describes using a series of simplifications to model the trains functionality and to compute the throttling and braking forces of the train. *See Gruber, page 537*. Additionally, Gruber, at page 542, recites "there is a need of approximating or estimating [the individual rail car] velocities…", and as such, the sensor data relating to the individual rail car velocities is not collected. Moreover, Applicant respectfully submits that "an exchange of information along a train" does not describe collecting sensor data.

Furthermore, Applicant respectfully traverses the suggestion in the Office Action at page 5, paragraph 12, that Gruber describes determining a consist force balance. Specifically, the Office Action, at page 14, paragraph 33, suggests that the "coupler forces" read on the claimed "consist force balance". Applicant traverses this suggestion. Specifically, Applicant submits that Gruber does not describe or suggest determining a consist force balance. Rather, and as indicated by the Examiner at page 14, paragraph 33 of the Office Action, "the objective of the control is to minimize the coupler forces..." However, and in contrast to the suggestion of the Examiner, Applicant submits that this objective does not correspond to an equilibrium or balance of zero coupler forces as suggested in the Office Action. Rather, the train consist is constantly subject to non-zero coupler forces as the train consist is subject to throttling and braking. Moreover, this objective of minimizing coupler forces is non-analogous to the recitations of Claim 1. Specifically, Claim 1 recites a method including "determining a consist force balance utilizing the sensor data and the computer." Gruber neither describes nor suggests determining a consist force balance. In fact, Applicant submits that Gruber does not describe or suggest determining a consist force balance, but rather, Gruber describes an equation for determining the momentum of the train based on the mass of the train and the velocity vector of the train, and does not determine a consist force balance as recited in Claim 1. Accordingly, for the reasons set forth above, Claim 1 is submitted to be patentable over Gruber.

Claim 2 depends from independent Claim 1 and further recites that said step of collecting sensor data comprises the steps of: monitoring a force applied to the consist utilizing the at least one measurement sensor; generating force data with respect to the force applied; and communicating the force data to the computer. Applicant submits that when the recitations of Claim 2 are considered in combination with the recitations of Claim 1, the recited method for

predicting train consist reactions is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 2 is patentable over Gruber.

Claim 3 depends from independent Claim 1 and further recites that said step of determining a consist force balance comprises the step of determining a set of consist kinetic elements. Applicant submits that when the recitations of Claim 3 are considered in combination with the recitations of Claim 1, the recited method for predicting train consist reactions is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 3 is patentable over Gruber.

Claim 15 depends from Claim 3 which depends from independent Claim 1 and further recites that said step of determining a set of kinetic elements further comprises the step of determining traction force. Applicant submits that when the recitations of Claim 15 are considered in combination with the recitations of Claims 1 and 3, the recited method for predicting train consist reactions is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 15 is patentable over Gruber.

Claim 16 depends from Claim 3 which depends from independent Claim 1 and further recites that said step of determining a force balance further comprises the step of summing the set of consist kinetic elements. Applicant submits that when the recitations of Claim 16 are considered in combination with the recitations of Claims 1 and 3, the recited method for predicting train consist reactions is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 16 is patentable over Gruber.

Claim 23 recites a system for predicting reactions of a train consist to specific stimuli, wherein the system includes at least one measurement sensor located on the train consist, a data

base, and a computer, the train consist includes at least one locomotive and at least one railcar, wherein the system is configured to "collect sensor data as the consist is moving...determine a consist force balance utilizing the sensor data and said computer...determine a set of consist coefficients using said computer...predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients."

Gruber does not describe or suggest a system for predicting reactions of a train consist to specific stimuli as recited in Claim 23. More specifically, Gruber does not describe or suggest a system configured to collect sensor data as the consist is moving, determine a consist force balance utilizing the sensor data, and predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients. Rather, in contrast to the present invention, Gruber describes a controller for operating multi-locomotive powered trains using sub-optimal control strategies derived from two different small scale train models and adapted to determine the operations of the long train. Notably, Gruber does not describe collecting sensor data and determining a train force balance using sensor data. As such, Gruber does not describe predicting train consist kinetic characteristic values using the consist force balance. Accordingly, for the reasons set forth above, Claim 23 is submitted to be patentable over Gruber.

Claim 24 depends from independent Claim 23 and further recites that said system is configured to: monitor a force applied to the consist utilizing said at least one measurement sensor; generate force data with respect to the force applied; and communicate the force data to said computer. Applicant submits that when the recitations of Claim 24 are considered in combination with the recitations of Claim 23, the recited system is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 24 is patentable over Gruber.

Claim 25 depends from independent Claim 23 and further recites that said system further configured to determine a set of consist kinetic elements. Applicant submits that when the recitations of Claim 25 are considered in combination with the recitations of Claim 23, the recited system is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 25 is patentable over Gruber.

Claim 37 depends from Claim 25 which depends from independent Claim 23 and further recites that said system further configured to determine traction force. Applicant submits that when the recitations of Claim 37 are considered in combination with the recitations of Claims 23 and 25, the recited system is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 37 is patentable over Gruber.

Claim 38 depends from Claim 25 which depends from independent Claim 23 and further recites that said system further configured to sum said set of consist kinetic elements. Applicant submits that when the recitations of Claim 38 are considered in combination with the recitations of Claims 23 and 25, the recited system is not taught nor suggested by Gruber, and accordingly, Applicant submits that dependent Claim 38 is patentable over Gruber.

For at least the reasons set forth above, Applicant respectfully submits that the methods and systems recited in Claims 1-3, 15-16, 23-25 and 37-38 are patentably distinguishable over the cited art. Accordingly, Applicant respectfully requests that the final rejection be withdrawn, and the presently pending claims allowed.

D.   Claims 17-18 and 39-40 Are Nonobvious Over Gruber In View Of Claerbout FGDP And Further In View Of Claerbout PVI.

The following discussion sets forth the Section 103 rejections cited against the pending claims and summarizes current and applicable law with respect to obviousness. In addition, a discussion of the rejection with respect to each pending claim, in view of current and applicable law, is provided. A claim-by-claim analysis of the pending claims also is set forth.

1.   The Cited Rejections

In the Office Action dated March 09, 2005, and made final, Claims 17-18 and 39-40 were rejected as being unpatentable under 35 U.S.C. § 103(a) over Gruber in view of Claerbout FGDP and further in view of Claerbout PVI.

2.   Applicable Law With Respect To Obviousness

Section 103, in pertinent part provides:

> (a) A patent may not be obtained . . .if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

As is well established, to establish a *prima facie* case of obviousness, the Examiner must satisfy three requirements. First, the prior art relied upon, coupled with the knowledge generally available in the art at the time of the invention, must contain some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combine references. See *In re Fine*, 837 F.2d 1071, 1074, 5 U.S.P.Q.2d 1596, 1958 (Fed. Cir. 1988); *In re Skinner*, 2U.S.P.Q.2d 1788, 1790 (Bd. Pat. App. & Int. 1986). Second, the proposed modification of the prior art must have a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. See *Amgen, Inc. v. Chugai Pharm. Co.*, 927 F.2d 1200, 1209, 18 U.S.P.Q.2d 1016, 1023 (Fed. Cir. 1991); *In re Erlich*, 3 U.S.P.Q.2d 1011, 1016 (Bd. Pat. App. & Int. 1986). Lastly, the prior art reference or combination of references

must teach or suggest all the limitations of the claims. See *In re Zurko*, 111 F.3d 887, 888-89, 42

U.S.P.Q.2d 1476, 1478 (Fed. Cir. 1997). And the teachings or suggestions, as well as the

expectations of success, must come from the prior art, not applicant's disclosure. See *In re*

Vaeck, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991).

Moreover, the Federal Circuit has determined that:

> [I]t is impermissible to use the claimed invention as an instruction manual or
> "template" to piece together the teachings of the prior art so that the claimed
> invention is rendered obvious. This court has previously stated that "[o]ne cannot
> use hindsight reconstruction to pick and choose among isolated disclosures in the
> prior art to deprecate the claimed invention."

In re Fitch, 23 USPQ2d 1780, 1784 (Fed. Cir. 1992), *citing, In re Gordan*, 221 USPQ at 1127.

Further, under Section 103, "it is impermissible . . .to pick and choose from any one reference

only so much of it as will support a given position, to the exclusion of other parts necessary to

the full appreciation of what such reference fairly suggests to one of ordinary skill in the art." *In*

re Wesslau, 147 USPQ 391, 393 (CCPA 1965). See also, *Smithkline Diagnostics, Inc. v. Helena*

Laboratories, Corp., 8 USPQ2d 1468, 1475 (Fed. Cir. 1988) ("claims, entire prior art, and prior

art patents must be read 'as a whole'"). Also, if art "teaches away" from a claimed invention,

such a teaching supports the nonobviousness of the invention. *U.S. v. Adams*, 148 USPQ 479

(1966); *Gillette Co. v. S.C. Johnson & Son, Inc.*, 16 USPQ2d 1923, 1927 (Fed. Cir. 1990).

3.   The Section 103 Rejection Of The Present Claims Is Not A Proper Prima Facie Obvious
        Rejection

Applicant respectfully submits that the Section 103(a) rejection of Claims 17-18 and 39-

40 as being unpatentable under 35 U.S.C. § 103(a) over Gruber in view of Claerbout FGDP and

further in view of Claerbout PVI is not a proper rejection.

Gruber is described above. Claerbout FGDP describes the use of the least squares method to develop a wave shaping filter, such as a prediction-error filter. Moreover, Claerbout PVI describes the use of spectral factorization of an inverse spectrum to obtain a prediction-error filter.

Applicant reiterates that the Section 103 rejection of the presently pending claims is not a proper rejection. As is well established, obviousness cannot be established by combining the teachings of the cited art to produce the claimed invention, absent some teaching, suggestion, or incentive supporting the combination. None of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe or suggest the claimed combination. Furthermore, in contrast to the assertion within the Office Action, Applicant respectfully submits that it would not be obvious to one skilled in the art to combine Gruber with any of Claerbout FGDP or Claerbout PVI, because there is no motivation to combine the references suggested in the art. Additionally, the Examiner has not pointed to any prior art that teaches or suggests to combine the disclosures, other than Applicant's own teaching. Rather, only the conclusory statement that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Gruber with those of Claerbout FGDP, because Claerbout PVI teaches that the use of the least squares method was a well-known step backwards in the art" suggests combining the disclosures.

As the Federal Circuit has recognized, obviousness is not established merely by combining references having different individual elements of pending claims. *Ex parte Levengood*, 28 U.S.P.Q.2d 1300 (Bd. Pat. App. & Inter. 1993). MPEP 2143.01. Rather, there must be some suggestion, outside of Applicant's disclosure, in the prior art to combine such

references, and a reasonable expectation of success must be both found in the prior art, and not based on Applicant's disclosure. *In re Vaeck*, 20 U.S.P.Q.2d 1436 (Fed. Cir. 1991). In the present case, neither a suggestion or motivation to combine the prior art disclosures, nor any reasonable expectation of success has been shown.

Furthermore, it is impermissible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the cited art so that the claimed invention is rendered obvious. Specifically, one cannot use hindsight reconstruction to pick and choose among isolated disclosures in the art to deprecate the claimed invention. Further, it is impermissible to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art. The present Section 103 rejection is based on a combination of teachings selected from multiple patents in an attempt to arrive at the claimed invention. Since there is no teaching or suggestion in the cited art for the combination, the Section 103 rejection appears to be based on a hindsight reconstruction in which isolated disclosures have been picked and chosen in an attempt to deprecate the present invention. Of course, such a combination is impermissible, and for this reason alone, Applicant requests that the Section 103 rejection be withdrawn.

Further, and to the extent understood, none of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe or suggest the claimed combination, and as such, the presently pending claims are patentably distinguishable from the cited combination. Specifically, Claim 1 recites a method for predicting train consist reactions to specific stimuli using a system including at least one measurement sensor located on a train consist, a data base,

and a computer, the train consist including at least one locomotive and at least one railcar, wherein the method includes "collecting sensor data as the consist is moving...determining a consist force balance utilizing the sensor data and the computer...determining a set of consist coefficients using the computer...predicting train consist kinetic characteristic values using the consist force balance and the set of consist coefficients."

None of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe nor suggest a method for predicting train consist reactions to specific stimuli as recited in Claim 1. More specifically, none of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe nor suggest a method including collecting sensor data as the consist is moving, determining a consist force balance utilizing the sensor data, and predicting train consist kinetic characteristic values using the consist force balance and a set of consist coefficients. Rather, in contrast to the present invention, Gruber describes a controller for operating multi-locomotive powered trains using sub-optimal control strategies derived from two different small scale train models and adapted to determine the operations of the long train, Claerbout FGDP describes the use of the least squares method to develop a wave shaping filter, such as a prediction-error filter, and Claerbout PVI describes the use of spectral factorization of an inverse spectrum to obtain a prediction-error filter. Accordingly, for the reasons set forth above, Claim 1 is submitted to be patentable over Gruber in view of Claerbout FGDP and further in view of Claerbout PVI.

Claim 17 depends from independent Claim 1 and further recites that said step of determining a set of consist coefficients comprises the step of using a least squares method to determine consist coefficients. Applicant submits that when the recitations of Claim 17 are

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considered in combination with the recitations of Claim 1, the recited method for predicting train consist reactions is not taught nor suggested by any of Gruber, Claerbout FGDP, and Claerbout PVI, and accordingly, Applicant submits that dependent Claim 17 is patentable over Gruber in view of Claerbout FGDP and further in view of Claerbout PVI.

Claim 18 depends from Claim 17 which depends from independent Claim 1 and further recites that said step of using the least squares method comprises the steps of: weighting data; solving the system; and determining a confidence measure. Applicant submits that when the recitations of Claim 18 are considered in combination with the recitations of Claims 1 and 17, the recited method for predicting train consist reactions is not taught nor suggested by any of Gruber, Claerbout FGDP, and Claerbout PVI, and accordingly, Applicant submits that dependent Claim 18 is patentable over Gruber.

Claim 23 recites a system for predicting reactions of a train consist to specific stimuli, wherein the system includes at least one measurement sensor located on the train consist, a data base, and a computer, the train consist includes at least one locomotive and at least one railcar, wherein the system is configured to "collect sensor data as the consist is moving...determine a consist force balance utilizing the sensor data and said computer...determine a set of consist coefficients using said computer...predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients."

None of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe nor suggest a system for predicting train consist reactions to specific stimuli as recited in Claim 23. More specifically, none of Gruber, Claerbout FGDP, or Claerbout PVI, considered alone or in combination, describe nor suggest a system configured to collect sensor data as the

consist is moving, determine a consist force balance utilizing the sensor data, and predict train

consist kinetic characteristic values using the consist force balance and the set of consist

coefficients. Rather, in contrast to the present invention, Gruber describes a controller for

operating multi-locomotive powered trains using sub-optimal control strategies derived from two

different small scale train models and adapted to determine the operations of the long train,

Claerbout FGDP describes the use of the least squares method to develop a wave shaping filter,

such as a prediction-error filter, and Claerbout PVI describes the use of spectral factorization of

an inverse spectrum to obtain a prediction-error filter. Accordingly, for the reasons set forth

above, Claim 23 is submitted to be patentable over Gruber in view of Claerbout FGDP and

further in view of Claerbout PVI.

Claim 39 depends from independent Claim 23 and further recites that said system further

configured to use a least squares method to determine consist coefficients. Applicant submits

that when the recitations of Claim 39 are considered in combination with the recitations of Claim

23, the recited method for predicting train consist reactions is not taught nor suggested by any of

Gruber, Claerbout FGDP, and Claerbout PVI, and accordingly, Applicant submits that dependent

Claim 39 is patentable over Gruber in view of Claerbout FGDP and further in view of Claerbout

PVI.

Claim 40 depends from Claim 39 which depends from independent Claim 23 and further

recites that said system further configured to: weight data; solve the system; and determine a

confidence measure. Applicant submits that when the recitations of Claim 40 are considered in

combination with the recitations of Claims 23 and 39, the recited system is not taught nor

suggested by any of Gruber, Claerbout FGDP, and Claerbout PVI, and accordingly, Applicant submits that dependent Claim 40 is patentable over Gruber.

For at least the reasons set forth above, Applicant respectfully submits that the methods and systems recited in Claims 17-18 and 39-40 are patentably distinguishable over the cited art. Accordingly, Applicant respectfully requests that the final rejection be withdrawn, and the presently pending claims allowed.

Respectfully submitted,

William Zychlewicz
Registration No. 51,366
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740
(314) 621-5070

XIII. CLAIMS INVOLVED IN THE APPEAL

1. A method for predicting train consist reactions to specific stimuli using a system including at least one measurement sensor located on a train consist, a data base, and a computer, the train consist including at least one locomotive and at least one railcar, said method comprising the steps of:

collecting sensor data as the consist is moving;

determining a consist force balance utilizing the sensor data and the computer;

determining a set of consist coefficients using the computer; and

predicting train consist kinetic characteristic values using the consist force balance and the set of consist coefficients.

2. A method in accordance with Claim 1 wherein said step of collecting sensor data comprises the steps of:

monitoring a force applied to the consist utilizing the at least one measurement sensor;

generating force data with respect to the force applied; and

communicating the force data to the computer.

3. A method in accordance with Claim 1 wherein said step of determining a consist force balance comprises the step of determining a set of consist kinetic elements.

4. A method in accordance with Claim 3 wherein said step of determining a set of consist kinetic elements comprises the step of determining rolling forces according to the equation:

$$F_{(rf)} = M (K_r + K_{rv} v(t))$$

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train; and

$v(t)$ is the speed of the train as a function of time.

5. A method in accordance with Claim 3 wherein said step of determining a set of consist kinetic elements further comprises the step of determining aerodynamic forces according to the equation:

$$F_{(af)} = K_a \, v(t)^2$$

wherein

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction; and

$v(t)$ is the speed of the train as a function of time.

6. A method in accordance with Claim 3 wherein said step of determining a set of consist kinetic elements further comprises the step of determining elevation caused forces according to the equation:

$$F_{(ef)} = M \, (K_{e1} \, E_1(t) + K_{e2} \, E_2(t) + K_{e3} \, E_3(t) + K_{e4} \, E_4(t))$$

wherein

$F_{(ef)}$ relates to the elevation caused forces of the train;

M is the total train mass;

K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is the elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train; and

$E_4(t)$ is the elevation function relating to the fourth segment.

7. A method in accordance with Claim 3 wherein said step of determining a set of consist kinetic elements further comprises the step of determining braking forces caused by direction changes according to the equation:

$$F_{(dbf)} = M (K_p C_p(t) + K_l C_l(t))$$

wherein

$F_{(dbf)}$ relates to the dynamic braking force of the train;

M is the total train mass;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train; and

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$C_l(t)$ is the braking effect caused by the lateral friction.

8. A method in accordance with Claim 3 wherein the at least one railcar includes at least one brake shoe, said step of determining a set of consist kinetic elements further comprises the step of determining consist brake forces caused by application of the at least one brake shoe according to the equation:

$$F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$$

wherein

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train; and

$B_4(t)$ is the brake function relating to the fourth segment.

9. A method in accordance with Claim 8 wherein said step of determining consist brake forces caused by application of the at least one brake shoe further comprises the steps of:

determining friction coefficients of the at least one brake shoe;

determining total brake application forces; and

determining total brake release forces.

10. A method in accordance with Claim 9 wherein said step of determining total brake application forces comprises the step of determining a brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = min(0, max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f$$

wherein

Bf_f is the braking force of the train for fast building pressure;

T is the traction force of the train; and

Bc_f is the brake cylinder force of the train.

11. A method in accordance with Claim 9 wherein said step of determining total brake application forces comprises the step of determining a brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = min(0, max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3))) Bc_s$$

wherein

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure; and

Bc_s is the brake cylinder force of the train.

12. A method in accordance with Claim 9 wherein said step of determining total brake release forces comprises the step of determining brake release using a fast release model according to the equation:

$$Rf_f = min(0, max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3))) Bc_f$$

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wherein

Rf_f relates to the fast release force of the train;

t is the time; and

Bc_f is the brake cylinder force of the train.

13. A method in accordance with Claim 9 wherein said step of determining total brake release forces comprises the step of determining brake release using a slow release model according to the equation:

$$Rf_s = min(0, max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3))) Bc_s$$

wherein

Rf_s relates to the slow release force of the train;

t is the time; and

Bc_s is the brake cylinder force of the train.

14. A method in accordance with Claim 3 wherein said step of determining a set of consist kinetic elements further comprises the step of determining dynamic brake force according to the equation:

$$F_{(dbf)} = K_d D(t)$$

wherein

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application; and

$D(t)$ is the dynamic brake force of the train.

15. A method in accordance with Claim 3 wherein said step of determining a set of kinetic elements further comprises the step of determining traction force.

16. A method in accordance with Claim 3 wherein said step of determining a force balance further comprises the step of summing the set of consist kinetic elements.

17. A method in accordance with Claim 1 wherein said step of determining a set of consist coefficients comprises the step of using a least squares method to determine consist coefficients.

18. A method in accordance with Claim 17 wherein said step of using the least squares method comprises the steps of:

weighting data;

solving the system; and

determining a confidence measure.

19. A method in accordance with Claim 1 wherein said step of predicting consist characteristic values comprises the steps of:

determining an acceleration prediction;

determining a speed after one minute prediction using the acceleration prediction; and

determining a shortest braking distance prediction using the acceleration prediction.

20. A method in accordance with Claim 19 wherein said step of determining an acceleration prediction comprises the steps of:

determining initial values; and

storing the initial values in the database.

21. A method in accordance with Claim 20 wherein said step of determining an acceleration prediction further comprises the step of determining the acceleration prediction value using a Euler method and the determined initial values.

22. A method in accordance with Claim 20 wherein said step of determining an acceleration prediction further comprises the step of determining the acceleration prediction value using a Milne method and the determined initial values.

23. A system for predicting reactions of a train consist to specific stimuli, said system comprising at least one measurement sensor located on the train consist, a data base, and a computer, the train consist comprising at least one locomotive and at least one railcar, said system configured to:

collect sensor data as the consist is moving;

determine a consist force balance utilizing the sensor data and said computer;

determine a set of consist coefficients using said computer; and

predict train consist kinetic characteristic values using the consist force balance and the set of consist coefficients.

24. A system in accordance with Claim 23 wherein to collect sensor data said system further configured to:

monitor a force applied to the consist utilizing said at least one measurement sensor;

generate force data with respect to the force applied; and

communicate the force data to said computer.

25. A system in accordance with Claim 23 wherein to determine a consist force balance, said system further configured to determine a set of consist kinetic elements.

26. A system in accordance with Claim 25 wherein to determine a set of consist kinetic elements, said system further configured to determine rolling forces according to the equation:

$$F_{(rf)} = M (K_r + K_{rv} \, v(t))$$

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train; and

v(t) is the speed of the train as a function of time.

27. A system in accordance with Claim 25 wherein to determine a set of consist kinetic elements, said system further configured to determine aerodynamic forces according to the equation:

$$F_{(af)} = K_a \, v(t)^2$$

wherein

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction; and

v(t) is the speed of the train as a function of time.

28. A system in accordance with Claim 25 wherein to determine a set of consist kinetic elements, said system further configured to determine elevation caused forces according to the equation:

$$F_{(ef)} = M (K_{e1} \, E_1(t) + K_{e2} \, E_2(t) + K_{e3} \, E_3(t) + K_{e4} \, E_4(t))$$

wherein

$F_{(ef)}$ relates to the elevation caused forces of the train;

M is the total train mass;

K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is the elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train; and

$E_4(t)$ is the elevation function relating to the fourth segment.

29. A system in accordance with Claim 25 wherein to determine a set of consist kinetic elements, said system further configured to determine braking forces caused by direction changes according to the equation:

$$F_{(dbf)} = M (K_p C_p(t) + K_1 C_1(t))$$

wherein

$F_{(dbf)}$ relates to the dynamic braking force of the train;

M is the total train mass;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train; and

$C_l(t)$ is the braking effect caused by the lateral friction.

30.   A system in accordance with Claim 25 wherein said at least one railcar comprises at least one brake shoe, and to determine a set of consist kinetic elements, said system further configured to determine consist brake forces caused by application of said at least one brake shoe according to the equation:

$$F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$$

wherein

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train; and

$B_4(t)$ is the brake function relating to the fourth segment.

31.   A system in accordance with Claim 30 wherein to determine consist brake forces caused by application of said at least one brake shoe, said system further configured to:

determine friction coefficients of said at least on brake shoe;

determine total brake application forces; and

determine total brake release forces.

32. A system in accordance with Claim 31 wherein to determine total brake application forces, said system further configured to determine a brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = \min(0, \max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f.$$

wherein

Bf_f is the braking force of the train for fast building pressure;

T is the traction force of the train; and

Bc_f is the brake cylinder force of the train.

33. A system in accordance with Claim 31 wherein to determine total brake application forces, said system further configured to determine a brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = \min(0, \max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3))) Bc_s$$

wherein

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure; and

Bc_s is the brake cylinder force of the train.

34. A system in accordance with Claim 31 wherein to determine total brake release forces, said system further configured to determine brake release using a fast release model according to the equation:

$$Rf_f = \min(0, \max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3))) Bc_f$$

wherein

Rf_f relates to the fast release force of the train;

t is the time; and

Bc_f is the brake cylinder force of the train.

35. A system in accordance with Claim 31 wherein to determine total brake release forces, said system further configured to determine brake release using a slow release model according to the equation:

$$Rf_s = \min(0, \max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3))) Bc_s$$

wherein

Rf_s relates to the slow release force of the train;

t is the time; and

Bc_s is the brake cylinder force of the train.

36. A system in accordance with Claim 25 wherein to determine a set of consist kinetic elements, said system further configured to determine dynamic brake force according to the equation:

$$F_{(dbf)} = K_d D(t)$$

wherein

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application; and

D(t) is the dynamic brake force of the train.

37. A system in accordance with Claim 25 wherein to determine a set of kinetic elements, said system further configured to determine traction force.

38. A system in accordance with Claim 25 wherein to determine a force balance, said system further configured to sum said set of consist kinetic elements.

39. A system in accordance with Claim 23 wherein to determine a set of consist coefficients, said system further configured to use a least squares method to determine consist coefficients.

40. A system in accordance with Claim 39 wherein to use the least squares, said system further configured to:

weight data;

solve the system; and

determine a confidence measure.

41. A system in accordance with Claim 23 wherein to predict consist characteristic values, said system further configured to:

determine an acceleration prediction;

determine a speed after one minute prediction using said acceleration prediction; and

determine a shortest braking distance prediction using said acceleration prediction.

42. A system in accordance with Claim 41 wherein to determine an acceleration prediction, said system further configured to:

determine initial values; and

store the initial values in said database.

43. A system in accordance with Claim 42 wherein to determine an acceleration prediction, said system further configured to determine the acceleration prediction value using a Euler method and said determined initial values.

44. A system in accordance with Claim 20 wherein to determine an acceleration prediction, said system further configured to determine the acceleration prediction value using a Milne method and the determined initial values.

45. A method for determining a force balance for a train consist using a system including at least one measurement sensor located on the train consist, a data base, and a computer, the train consist including at least one locomotive and at least one railcar, the railcar including at least one brake shoe, said method comprising the steps of:

monitoring a force applied to the consist utilizing the at least one measurement sensor;

generating force data with respect to the force applied;

communicating the force data to the computer;

determining rolling forces according to the equation $F_{(rf)} = M (K_r + K_{rv} v(t))$,

determining aerodynamic forces according to the equation $F_{(af)} = K_a v(t)^2$,

determining elevation caused forces according to the equation $F_{(ef)} = M (K_{e1} E_1(t) + K_{e2} E_2(t) + K_{e3} E_3(t) + K_{e4} E_4(t))$,

determining braking forces caused by direction changes according to the equation

$F_{(dbf)} = M (K_p C_p(t) + K_l C_l(t))$;

determining consist brake forces caused by application of the at least one brake shoe according to the equation $F_{(baf)} = K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t)$;

determining brake application dragging force using a fast building pressure model according to the equation:

$$Bf_f = min(0, max(1, (T + 3.86950758 * T^2 + 0.23164628 * T^3) / (16367.9101 + 111.652789 * T + 27.6134504\ 8 * T^2 - 0.0026229 * T^3))) Bc_f ;$$

determining brake application dragging force using a slow building pressure model according to the equation:

$$Bf_s = min(0, max(1, (T_s + 2.00986206 * T_s^2 + 0.81412194 * T_s^3) / (0.00067603 + 169.361303 * T_s + 8.95254599 * T_s^2 + 0.58477705 * T_s^3));$$

determining brake release using a fast release model according to the equation:

$$Rf_f = min(0, max(1, (t + 3.86950758 * t^2 + 0.23164628 * t^3) / (16367.9101 + 111.652789 * t + 27.6134504\ 8 * t^2 - 0.0026229 * t^3))) Bc_f ,$$

determining brake release using a slow release model according to the equation:

$$Rf_s = min(0, max(1, (t + 2.00986206 * t^2 + 0.81412194 * t^3) / (0.00067603 + 169.361303 * t + 8.95254599 * t^2 + 0.58477705 * t^3))) Bc_s$$

determining dynamic brake force according to the equation $F_{(dbf)} = K_d D(t)$,

determining traction force; and

determining a final solution according to the equation:

$$F(t) = M (K_r + K_{rv} v(t)) + K_a v(t)^2 +$$
$$M K_{e1} E_1(t) + M K_{e2} E_2(t) + M K_{e3} E_3(t) + M K_{e4} E_4(t) +$$
$$M K_p C_p(t) + M K_l C_l(t) +$$

$$K_{b1} B_1(t) + K_{b2} B_2(t) + K_{b3} B_3(t) + K_{b4} B_4(t) +$$

$$K_{r1} R_1(t) + K_{r2} R_2(t) + K_{r3} R_3(t) + K_{r4} R_4(t) + K_d D(t) + K_t T(t)$$

wherein

$F_{(rf)}$ relates to the rolling forces of the train;

M is the total train mass;

K_r is the corrective factor for friction of the train;

K_{rv} is the dynamic corrective factor for friction of the train;

$v(t)$ is the speed of the train as a function of time;

$F_{(af)}$ relates to the aerodynamic forces of the train;

K_a is the corrective factor for the effect of the aerodynamic friction;

$F_{(ef)}$ relates to the elevation caused forces of the train;

K_{e1} is the corrective factor for the effect of the elevation change on a first segment of the train;

$E_1(t)$ is the elevation function relating to the first segment;

K_{e2} is the corrective factor for the effect of the elevation change on a second segment of the train;

$E_2(t)$ is the elevation function relating to the second segment;

K_{e3} is the corrective factor for the effect of the elevation change on a third segment of the train;

$E_3(t)$ is an elevation function relating to the third segment;

K_{e4} is the corrective factor for the effect of the elevation change on a fourth segment of the train;

$E_4(t)$ is an elevation function relating to the fourth segment;

$F_{(dbf)}$ relates to the dynamic braking force of the train;

K_p is the corrective factor for the weight increase of the train;

$C_p(t)$ is the braking effect caused by the weight increase;

K_l is the corrective factor for the effect of the lateral friction of the train;

$C_l(t)$ is the braking effect caused by the lateral friction;

$F_{(baf)}$ relates to the applied braking forces of the train;

K_{b1} is the brake function coefficient relating to a first segment of the train;

$B_1(t)$ is the brake function relating to the first segment;

K_{b2} is the brake function coefficient relating to a second segment of the train;

$B_2(t)$ is the brake function relating to the second segment;

K_{b3} is the brake function coefficient relating to a third segment of the train;

$B_3(t)$ is the brake function relating to the third segment;

K_{b4} is the brake function coefficient relating to a fourth segment of the train;

$B_4(t)$ is the brake function relating to the fourth segment;

Bf$_f$ is the braking force of the train for fast building pressure;

T is the traction force of the train;

Bc$_f$ is the brake cylinder force of the train;

Bf_s is the braking force of the train for slow building pressure;

T_s is the traction force for the slow building pressure;

Bc_s is the brake cylinder force of the train;

Rf_f relates to the fast release force of the train;

t is the time;

Rf_s relates to the slow release force of the train;

$F_{(dbf)}$ relates to the dynamic brake force;

K_d is the corrective factor for the effect of the dynamic brake application;

$D(t)$ is the dynamic brake force of the train;

$F(t)$ is the force balance of the train;

K_{r1} is the corrective factor for friction in the first segment of the train;

$R_1(t)$ is the release function of the first segment;

K_{r2} is the corrective factor for friction in the second segment of the train;

$R_2(t)$ is the release function of the second segment;

K_{r3} is the corrective factor for friction in the third segment of the train;

$R_3(t)$ is the release function of the third segment;

K_{r4} is the corrective factor for friction in the fourth segment of the train;

$R_4(t)$ is the release function of the fourth segment; and

K_d is the corrective factor for the effect of the dynamic brake application.

IX. EVIDENCE APPENDIX

There is no evidence being submitted pursuant to 37 CFR §§ 1.130, 1.131, or 1.132, or of any other evidence entered by the examiner and relied upon by appellant in the appeal, and there is no statement being submitted setting forth where in the record that evidence was entered in the record by the examiner.

X.   RELATED PROCEEDINGS APPENDIX

There are no related proceedings which will directly affect, or be directly affected by, or have a bearing on, the decision in this pending appeal.